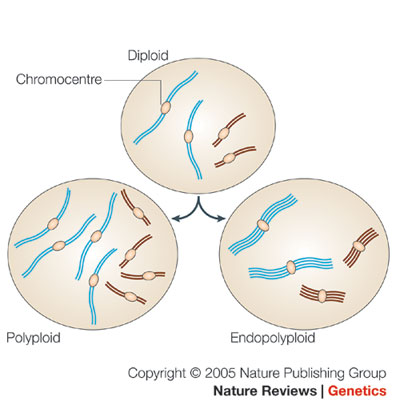
***Spartina* spp evolution**

An organism is said to be polyploidy if it has more than two complete sets of chromosomes. In plant species, polyploidy can be extremely important in the expansion and institution of new populations, with 30-80% of plant species being polyploidy (Hartl, 2009). The biochemical complexity of plants, often altered by polyploidy events, can be beneficial in that it allows variation of gene expression; aiding survival and adaptation to different environments. However, the new chromosome numbers produced often lead to lack of fertility due to lack of ability to combine with the original haploid number during fertilisation. Polyploidy plants can arise for many reasons, including the fusion of non-haploid gametes and mitotic/meiotic errors.  
  
  
  
  
Available at: http://www.nature.com/nrg/journal/v6/n11/images/nrg1711-i1.jpg  
  
Meiosis is the process of gamete production. Many reasons can cause non-haploid gametes to be produced including meiotic non-dysfunction (production of a 2n oocyte – digyny - or pollen grain), or diandry, where two pollen grains fertilize an oocyte. Fertilization of such gametes will lead to polyploidy (beginning with a triploid zygote). In plants, it is common for such triploids to reproduce and create further polyploidy numbers, thus speciating genuses repeatedly.

There are two types of polyploidy, autopolyploidy occurs when chromosome double occurs within a species, resulting in doubled haploid numbers. Allopolyploidy is caused by a hybridization followed by a chromosome doubling.  
  
The doubling of chromosomes in allopolyploids, like S. anglica, can provide a range of new advantages that allow them to reproduce and spread. A potential problem would be that the plant would be affected by the bottleneck effect, especially due to their ability to asexually reproduce. However, the duplicates of chromosomes act like a buffer against any deleterious genes that could potentially be expressed (Comai, 2005). These duplicates provide future generations with more DNA to modify, through mutations, and might lead them to success and diversity in later generations. It has also been observed that polyploidy hybrids have increased vigour compared to the species they originated from; possibly due to the genes important in growth are being upregulated (Chen, 2007). But the doubling of these chromosomes appears to have a negative effect on gene regulation. Whilst the gene expression per cell might be expected to increase proportionally to the amount of DNA, the regulatory factors does not change proportionally to the cell, so gene expression would be prevented from changing proportionally (Guo, Davies, & Birchler, 1996). Finally, there can occasionally be difficulties during meiosis of allopolyploidy organisms when the chromosomes pair up with chromosomes from the parental genomes. In some cases, specific genes are required to ensure homologous pairs are formed, rather than homeologous pairs (Comai, 2005).

Most or all angiosperm species are believed to have experienced at least one round of polyploidy in their ancestry, indicating its importance in the evolution of the flowering plants. Certainly polyploidy has been a driving force behind speciation in the genus *Spartina* (Poaceae). The allopolyploid *Spartina anglica* (2n=4x=120, 122, 124) formed during the 19th century in Hythe, Southampton (Renny-Byfield, 2009). This happened after the introduction of the paleohexaploids *Spartina alterniflora* (2n=62) – a perennial grass native to the Atlantic coast of North America., and the native British *S. maritima* (2n=60), which inhabits the Atlantic coast of Africa and Europe. Interspecific hybridization produced the infertile hybrid *S. Townsendii* (2n=2x=60, 62), which was first identified in 1880 (Renny-Byfield, 2009).Many times in nature this would be considered an evolutionary dead end, but genome duplication in this hybrid resulted in the formation of the fertile allopolyploid *S. anglica* – a vigorous salt marsh species that has rapidly expanded in European salt marshes and has now colonized several continents.

A unique characteristic of the *Spartina* polyploid is its ability to live in a salt marsh. Salt marshes exist in inter-tidal zones where mudflats with a fresh water source meet salt water. They can happen along coastlines all over the world (Zhi et al 2007).   
  
An example of a recently formed salt marsh would be one of Porlock Bay on the south west coast of England. In 1996, a severe storm caused flooding of sea water into the farm lands beyond the shingle bank. This flooding killed most of the terrestrial vegetation, including crops, due to their intolerance for salt. This disturbance caused halophytes, or salt tolerating plants, to radiate into the new niche. The salt water from the tides affects the geological properties of the soil which can influence the biodiversity of organisms living there.

In a study conducted by Li, Shi & Fukuda (2010) beneficial adaptations have been found on effects of salt and alkali stresses on plant growth. *S. alterniflora* was found to be capable of surviving under relatively low pH regardless of the level of salinity, and at moderate alkalinity (pH ≤9.56), confirming its moderate alkali tolerance and high salt tolerance.

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|  | Porlock_Bay_SaltMarsh.jpg |

Salt marsh of Porlock Bay in Somerset, UK   
Photo by: F. Davies 2010

Evidences over the past decade have shown that allopolyploid genomes are particularly dynamic at both the structural and expression levels, and might result in new, putatively adaptive, phenotypes (Parisod et al. 2009). *Spartina's* halophytic characteristics along with its aggressive nature allows for strong inter-specific competition towards less hardy plants, including other species of itself (Zhi et al 2007). The speciations of such polyploid plants that have evolved inhabiting these transitional habitats, such as a salt marsh, are a valuable subject for scientific study and could prove that polyploidy is held responsible for aiding survival in such harsh conditions. Hybridization could also be responsible for variation among such species as seen in the genus *Spartina* by altering genomic numbers and the relative expression of particular genes.

**Conclusion**

Learning how these plants can live in these conditions would be an extremely valuable discovery for agriculture in a planet that has a growing population to feed but not enough space to grow crops in their appropriate habitats. If a plant can grow in a salt marsh, there could be a possibility to genetically modify existing crops to be able to tolerate this environment, thus, expanding farm land. This possibly could also lead to expanding into other harsh environments (eg. deserts) which would reduce the need to continue to destroy fragile and diverse ecosystems in order to feed the world.   
  
**WORD COUNT:** 1,032  
  
**References:**  
  
Ainouche, M. et al. 2009. Hybridization, polyploidy and invasion: lessons from *Spartina* (Poaceae). *Biological Invasions.* 11, pp. 1159-1173.  
  
Comai, L. (2005). The advantages and disadvantages of being polyploid. *Nature Reviews Genetics* , 6 (11), pp. 836-846.  
  
Hartl, D. et al. (2009) *Genetics: analysis of genes and genomes*. 7th ed. USA: Jones and Bartlett Publishers. pp.285.  
  
Li, R., Shi, F., .Fukuda, K., (2010). Interactive effects of various salt and alkali stresses on growth, organic solutes, and cation accumulation in a halophyte Spartina alterniflora (Poaceae). *Environmental and Experimental Botany,* 68 (1), pp 66-74.   
  
Parisod, C., Salmon, A., Zerjal, T., Tenaillon, M., Grandbastien, M.-A. and Ainouche, M. (2009), Rapid structural and epigenetic reorganization near transposable elements in hybrid and allopolyploid genomes in *Spartina*. *New Phytologist*, 184, pp.1003–1015.  
  
Renny-Byfield, S. (2009) Flow cytometry and GISH reveal mixed ploidy populations and Spartina nonaploids with genomes of S. alterniflora and S. maritima origin. *Annals of botany*, pp.105(4), 527 -533.   
  
Soltis, D. Soltis, P. 2009. The Role of Hybridization in Plant Speciation. [//Plant Biology//](http://www.annualreviews.org/journal/arplant)*.* [60](http://www.annualreviews.org/toc/arplant/60/1), pp.561-588.  
  
Zhi, Y., Li, H., An. S., Zhao, L., Zhou, C., & Deng, Z. 2007. Inter-specific competition: *Spartina alterniflora* is replacing *Spartina anglica* in coastal China. *Estuarine Coastal and Shelf Science*, 74, pp. 437- 448.